Optimization Review Report
Investigation Stage

West County Road 112 Ground Water Plume Superfund Site
Midland, Midland County, Texas
EPA Region 6

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OPTIMIZATION REVIEW

WEST COUNTY ROAD 112 GROUND WATER PLUME SUPERFUND SITE

MIDLAND, MIDLAND COUNTY, TEXAS

EPA REGION 6

FINAL REPORT

September 2016

EXECUTIVE SUMMARY

NATIONAL OPTIMIZATION STRATEGY BACKGROUND

The U.S. Environmental Protection Agency's (EPA's) definition of optimization is as follows:

> "*Efforts at any phase of the removal or remedial response to identify and implement specific actions that improve the effectiveness and cost-efficiency of that phase. Such actions may also improve the remedy's protectiveness and long-term implementation, which may facilitate progress towards site completion. To identify these opportunities, Regions may use a systematic site review by a team of independent technical experts, apply techniques or principles from Green Remediation or Triad, or apply some other approaches to identify opportunities for greater efficiency and effectiveness.*"[1]

An optimization review considers the goals of the remedy, available site data, conceptual site model (CSM), remedy performance, protectiveness, cost-effectiveness, and closure strategy. A strong interest in sustainability has also developed in the private sector and within Federal, state, and municipal governments. Consistent with this interest, green remediation, and environmental footprint reduction are now routinely considered during optimization reviews, when applicable.

An optimization review includes reviewing site documents, interviewing site stakeholders, potentially visiting the site for one day and compiling a report that includes recommendations intended to improve the following:

- Remedy effectiveness
- Cost reduction
- Technical improvement
- Progress to Site closure
- Environmental footprint reduction

The recommendations are intended to help the site team identify opportunities for improvements in these areas. In many cases, further analysis of a recommendation, beyond that provided in this report, may be needed prior to implementation of the recommendation. Note that the recommendations are based on an independent review and represent the opinions of the optimization review team. These recommendations do not constitute requirements for future action, but rather are provided for consideration by the EPA Region and other site stakeholders. Also, note that while the recommendations may provide some details to consider during implementation, the recommendations are not meant to replace other, more comprehensive, planning documents such as work plans, sampling plans, and quality assurance project plans (QAPPs).

The national optimization strategy includes a system for tracking consideration and implementation of the optimization recommendations and includes a provision for follow-up technical assistance from the optimization review team as mutually agreed upon by the site management team and EPA Office of Superfund Remediation and Technology Innovation (OSRTI).

[1] EPA, 2012. Memorandum: Transmittal of the National Strategy to Expand Superfund Optimization Practices from Site Assessment to Site Completion. From: James. E. Woolford, Director Office of Superfund Remediation and Technology Innovation. To: Superfund National Policy Managers (Regions 1 – 10). Office of Solid Waste and Emergency Response (OSWER) 9200.3-75. September 28.

SITE-SPECIFIC BACKGROUND

The West County Road 112 Ground Water Plume Superfund Site (WCR 112 or Site) is located in Midland County, Texas, EPA Region 6. The Site is the location of a dissolved chromium (Cr) groundwater plume of indeterminate source near an industrial park. The affected groundwater plume traverses the Midland city limits, originating north of Interstate-20 (I-20) and extending south to residential and agricultural property where groundwater is the sole water supply. The area of groundwater affected by Cr is approximately 2 miles in length and 1 mile in width.

The WCR 112 Site was included to the National Priorities List (NPL) in 2011 based on evidence of potential exposure of residents to Cr through private drinking water supply wells. The Site is currently in the Remedial Investigation and Feasibility Study (RI/FS) stage of remediation. Site activities are conducted as a Superfund-lead remedial project because no viable Potentially Responsible Parties were identified.

SUMMARY OF CONCEPTUAL SITE MODEL AND KEY FINDINGS

The primary contaminant of concern at the Site is Cr, with the soluble form of hexavalent chromium [Cr (VI)] accounting for the greatest risk. The current EPA Primary Drinking Water Standard Maximum Contaminant Level (MCL) and remedial goal for total Cr is 100 µg/L; however, the protectiveness of this standard is currently under review by several regulatory agencies.

In addition to the Cr plume, groundwater plumes containing chlorinated volatile organic compounds (VOC) emanate from the nearby 2707 South County Road 1208 (GE Site) and from the Schlumberger/Dowell Midland Facility (Schlumberger Site) north of the suspected source of Cr to groundwater. The VOC plume originating from the GE Site is west of the WCR 112 Site Cr plume and is not comingled. The VOC plume originating from the Schlumberger Site is comingled with the WCR 112 Site Cr plume south of I-20. Arsenic contamination, likely resulting from anaerobic aquifer conditions caused by releases of petroleum hydrocarbons, is associated with the Schlumberger plume.

Groundwater is the primary medium of concern at the Site. The Site south of I-20 contains over 200 private water supply wells. Sampling results from these locations have provided the majority of data to identify the extent and magnitude of the plume. Private water supply wells are typically drilled to the base of the Antlers Sand at 100 ft bgs and are screened across both aquifers.

The sole drinking water supply south of I-20 in Midland County consists of private water wells completed in the Ogallala Aquifer and deeper Antlers Sand, making ingestion of contaminated groundwater a potentially complete exposure pathway at the Site.

The local geology at the Site consists of windblown sand, silt, alluvium and playa lake deposits from ground surface to approximately 15 feet (ft) below ground surface (bgs). However, most surface soils in the immediate vicinity of the Site are thin to absent. Caliche deposits (cemented calcium carbonate) underlie much of the Site and separate surface soils from the underlying Ogallala Formation. Unsaturated deposits extend from near the ground surface to approximately 20 ft bgs and include silty sand, clayey sand, and gravel interspersed with caliche layers ranging from crumbly to very hard and impermeable to fractured in areas. Site sediments attributed to the Ogallala Formation are typically encountered between 10 ft to 60 ft bgs. The Ogallala Formation is saturated from 20 to 35 ft bgs and is unconfined. The lower contact between the Ogallala Formation and the Trinity Group ranges from approximately 38 to 64 ft bgs.

A clay layer, locally termed ‘false red beds’, consisting of red silty clay of 5 to 27 ft thick separates the base of the Ogallala from the Trinity. The Trinity Antlers Sand is found below 50 to 65 ft bgs and extends to a depth of 67 to 95 ft bgs. The Antlers Sand consists of saturated fine-grained sandstone containing scattered lenses of siltstone and coarse-grained sandstone with gravel in some locations. Contamination has been found in both the shallow Ogallala and lower Trinity Aquifers.

Primary data gaps associated with the WCR 112 Site include the geology and hydrogeology of the subsurface, particularly for the area south of I-20. Geophysical and boring logs as well as plume distribution indicate there are preferential vertical and transverse plume migration pathways.

The Site is in the RI/FS stage of remediation, and a remedy has not yet been selected. The Texas Commission on Environmental Quality (TCEQ) is currently operating point of use (POU) anion exchange systems for area residents with groundwater exceeding health standards to address the groundwater ingestion exposure pathway. The cost and level of effort to maintain the anion exchange resins in the POU systems is high.

The findings of the optimization team based on a review of Site documents, Site visit, and discussions with EPA and TCEQ are:

- Groundwater plume migration is not controlled. Plumes are expanding southward.
- Multiple private water supply wells south of I-20 draw water from contaminated aquifer zones. Cr concentrations are above the EPA MCL of 100 µg/L. Many other wells have concentrations between 10 µg/L and 100 µg/L, which is a range that may be regulated at some time in the future. Area private water supplies are also affected by elevated concentrations of arsenic and VOCs.
- Anion exchange POU treatment units on private water supply wells are expensive to maintain and may not be removing potential co-contaminants such as arsenic and 1,4-dioxane.
- Hydrogeology at the Site is complex. Potential connections between the upper Ogallala aquifer and the deeper Antlers Sand are not well established. Preferential channels may exist in both aquifers, influencing migration of contaminants. Data gaps include a lack of understanding of the communication between the shallow Ogallala Aquifer, the deeper Antlers Sand, and the intervening confining clays and gravel layers. The majority of the sampling locations south of I-20 are private water supply wells with long screened intervals. The number of monitoring wells that target specific depth intervals and include geological information from boring logs is sparse.
- Cr has migrated vertically to the Trinity in the area of WMW-05 near West County Road 114.
- The source of Cr releases to groundwater is unknown. Based on the distribution of mass in the plume, continued input of Cr from the source is limited. Further investigation or remediation at the historical source is likely unproductive.
- The majority of dissolved Cr mass has migrated south of I-20. No estimates of the total mass of Cr in the plumes have been developed. Estimates of the potential efficacy and cost of future remediation may be hard to predict.
- The distribution of Cr south of I-20 is largely based on data from private water supply wells where the sampling interval and elevation of the wells are not well documented. Supply wells are screened across both aquifers, but data are reported and mapped as Ogallala results, introducing uncertainty into estimates of the distribution of contamination.
- The Cr plume and a VOC plume originating from the Schlumberger Technology Corporation facility are comingled south of I-20.
- In situ reduction of Cr (VI) to Cr (III) may be an effective remedy at the site; however, any in situ treatments will most likely generate secondary metals such as Mn, Fe, and arsenic as well as odors that may affect water quality.

RECOMMENDATIONS

The following recommendations based on the Site findings were developed to support RI/FS and remedy selection:

- Investigate alternative sources of drinking water for residences with private supply wells.
  - Pursue long-term planning for extension of City of Midland municipal water supplies to the area south of I-20.
  - Supply bottled drinking water for residents downgradient from in situ treatment remedies or where the VOC and Cr plumes intermingle. Identify private water supply wells drawing from areas of the plume where Cr concentrations are between 10 and 100 µg/L.
  - Review POU treatment system design to determine if water for non-potable use can be diverted before treatment to extend the life of anion exchange resins;
- The optimization team recommends installation of additional monitoring wells to both define the magnitude and extent of contamination in the Ogallala Aquifer and Antlers Sand and provide better hydrogeologic characterization data on potential preferential flow paths.
  - Two nested monitoring wells are recommended along the trajectory of West County Road 116 west of GW-150 in order to evaluate current conditions and confirm groundwater flow direction.
  - An additional monitoring well in the Antlers Sand is recommended upgradient of WMW-05A/B (west of SWM-35) to evaluate Antlers Sand Cr concentrations upgradient of WMW-05A/B.
  - An additional monitoring well pair in the leading edge of the plume south and east of WMW-15 is recommended to confirm Cr concentrations detected in private supply wells south of GW-257 and to serve as a sentinel for future plume migration.
  - New and existing monitoring wells south of I-20 should be sampled semi-annually for four years during and after remedy installation to attain a statistically significant sample size.
- Develop detailed cross sections from data collected during installation of the additional groundwater monitoring wells.
- Exchange information on stratigraphy (borings in vicinity of pilot study) and potential mobilization of secondary metals from in situ reduction treatments with Schlumberger responsible parties.
- Prepare an Interim ROD selecting provision of alternate water supplies and in situ reduction treatment as interim remedies.
- Install an in situ treatment zone in the core of the plume south of I-20. The location of the treatment zone would be based on property access. Based on observations during the Site walk and discussions with the Site team, the mostly likely location of the treatment zone would be across the plume core in the vicinity of and parallel to West County Road 115. Conduct associated remedy performance monitoring.
- Groundwater extraction and treatment may be considered as a contingent remedy if in situ treatments fail to contain the Cr plume.

CONTENTS

TABLES

FIGURES

APPENDICES

NOTICE AND DISCLAIMER

Work described herein, including preparation of this report, was performed by HydroGeoLogic, Inc. (HGL) for the U.S. Environmental Protection Agency (EPA) under Task Order 0066 of EPA contract EP-S7-05-05 with HGL. The report was approved for release as an EPA document, following the Agency's administrative and expert review process.

This optimization review is an independent study funded by EPA that focuses on evaluation of existing data, discussion of conceptual site model, and analysis of remedy performance with the overall goal of providing suggestions for improvements in protectiveness, reductions in cost, and progress toward site closure at the West County Road 112 Ground Water Plume Superfund Site. Detailed consideration of EPA policy was not part of the scope of work for this review. This report does not impose legally binding requirements, confer legal rights, impose legal obligations, implement any statutory or regulatory provisions, or change or substitute for any statutory or regulatory provisions. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Recommendations are based on an independent evaluation of existing Site information, represent the technical views of the optimization review team, and are intended to help the Site team identify opportunities for improvements in the current Site remediation strategy and operation and maintenance plan. These recommendations do not constitute requirements for future action; rather, they are provided for consideration by the EPA Region and other Site stakeholders.

While certain recommendations may provide specific details to consider during implementation, these are not meant to supersede other, more comprehensive planning documents such as work plans, sampling plans and Quality Assurance Project Plans (QAPPS), nor are they intended to override Applicable or Relevant and Appropriate Requirements (ARARs). Further analysis of recommendations, including review of EPA policy, may be needed before implementation.

PREFACE

This report was prepared as part of a national strategy to expand Superfund optimization practices from site assessment to site completion implemented by the U.S. Environmental Protection Agency Office of Superfund Remediation and Technology Innovation (OSRTI)[2]. The project contacts are as follows:

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[2] EPA, 2012. Memorandum: Transmittal of the National Strategy to Expand Superfund Optimization Practices from Site Assessment to Site Completion. From: James. E. Woolford, Director Office of Superfund Remediation and Technology Innovation. To: Superfund National Policy Managers (Regions 1 – 10). Office of Solid Waste and Emergency Response (OSWER) 9200.3-75. September 28.

LIST OF ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
AO	Agreed Order
bgs	below ground surface
cm/sec	centimeters per second
COPC	contaminant of potential concern
Cr	chromium
Cr (III)	trivalent chromium,
Cr (VI)	hexavalent chromium
CSM	conceptual site model
1,1-DCE	1,1-dichloroethene
DO	dissolved oxygen
EPA	U.S. Environmental Protection Agency
ERD	enhanced reductive dechlorination
EVO	emulsified vegetable oil
Fe	iron
FS	Feasibility Study
ft	feet
ft/yr	feet per year
gpm	gallons per minute
HGL	HydroGeoLogic Incorporated
HQ	EPA Headquarters
HRS	Hazard Ranking System
ISCO	in situ chemical oxidation
K	hydraulic conductivity
MCL	Maximum Contaminant Level
Mn	manganese
NPL	National Priorities List
O&M	Operation and Maintenance
ORP	oxidation reduction potential
OSRTI	Office of Superfund Remediation and Technology Innovation
OSWER	Office of Solid Waste and Emergency Response

PCL	Protective Concentration Level
PHG	Public Health Goal
POU	point of use
PRP	potentially responsible party
P&T	pump and treat
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
RAO	Remedial Action Objective
RI	Remedial Investigation
ROD	Record of Decision
1,1,1-TCA	1,1,1-trichloroethane
TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
TDS	total dissolved solids
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TWC	Texas Water Commission
VOC	volatile organic compound
WCR 112	West County Road 112

1.0 OBJECTIVES OF THE OPTIMIZATION REVIEW

For more than a decade, the Office of Superfund Remediation and Technology Innovation (OSRTI) has provided technical support to the U.S. Environmental Protection Agency (EPA) regional offices by using independent (third party) optimization reviews at Superfund sites. The West County Road 112 Ground Water Plume Superfund Site (Site or WCR 112 Site) [CERCLA ID TXN000606992] was nominated for an optimization review at the request of the Region 6 Optimization Liaison in August 2015. The optimization review is intended to provide suggestions for a remedial strategy that will improve protectiveness, reduce cost, and improve progress toward attaining cleanup goal.

To this end, an optimization review team (described below) assembled and met with regulatory stakeholders and consultants at the Site and at Texas Commission on Environmental Quality (TCEQ) Midland, Texas, offices in September 2015. The goal of the meeting was to inspect the Site, review Site data, discuss remediation goals, and identify data gaps. This report is a summary of the recommendations of the optimization review team based on a review of Site documents and meeting with stakeholders.

This optimization review used existing environmental data to interpret the conceptual site model (CSM), identify potential data gaps, and recommend a remedial strategy. The optimization review team evaluated the quality of the existing data before using the data for these purposes. The evaluation for data quality included a brief review of how the data were collected and managed (where practical, the Site Quality Assurance Project Plan [QAPP] is considered), the consistency of the data with other Site data, and the use of the data in the optimization review. Data that were of suspect quality were either not used as part of the optimization review or were used with the quality concerns noted. Where appropriate, this report provides recommendations made to improve data quality.

2.0 OPTIMIZATION REVIEW TEAM

The optimization review team consisted of the independent, third-party participants listed below. The optimization review team collaborated with representatives of EPA Headquarters (HQ) and EPA Region 6.

TABLE 1. Optimization Review Team

NAME	ORGANIZATION	TELEPHONE	EMAIL
Kirby Biggs	EPA HQ	703-823-3081	biggs.kirby@epa.gov
Doug Sutton	HydroGeoLogic, Inc.	732-784-2812	dsutton@hgl.com
Mindy Vanderford	HydroGeoLogic, Inc.	713-865-2223	mvanderford@hgl.com

The following individuals contributed to the optimization review process, including attendance at the on-Site review meeting:

TABLE 2. Other Optimization Review Contributors

NAME	ORGANIZATION	EMAIL
Vince Malott	EPA Region 6	Optimization Coordinator
Marilyn Czimer Long	TCEQ	TCEQ Liaison
Makenzie Vessely	TCEQ	Project Manager
Frank Baranco	EA Engineering, Science and Technology, Inc.	EPA RAC
Louis Vega	EA Engineering, Science and Technology, Inc.	EPA RAC Project Manager
Stan Wallace	EA Engineering, Science and Technology, Inc.	EPA RAC

TCEQ = Texas Commission on Environmental Quality
RAC = Remedial Action Contract

A tour and meeting was held at the Site and TCEQ Regional Offices in Midland, Texas, on September 16, 2015. Documents reviewed for the optimization review effort are listed in Appendix A.

3.0 REMEDIAL ACTION OBJECTIVES AND SELECTED REMEDIES

3.1 SITE DESCRIPTION

The WCR 112 Site is located in Midland County, Texas, EPA Region 6. The Site traverses the Midland city limits, originating north of Interstate-20 (I-20) near the intersection of East and South Industrial Loop roads, extending south to approximately West County Road 126 (Figure 1). The Site is the location of a dissolved chromium (Cr) groundwater plume of indeterminate source near an industrial park. The area of groundwater affected by Cr is approximately 2 miles in length and 1 mile in width. Affected groundwater underlies mixed commercial, industrial, residential, and agricultural properties. Properties north of I-20 are served by City of Midland municipal water supplies. The sole water supply south of I-20 in Midland County consists of private water wells completed in the Ogallala Aquifer and deeper Antlers Sand.

In addition to the Cr plume, groundwater plumes containing chlorinated volatile organic compounds (VOC) emanate from 2707 South County Road 1208 (GE Site) and from the Schlumberger/Dowell Midland Facility at Industrial Avenue and East Industrial Loop (Schlumberger Site). The VOC plume originating from the GE Site is west of the WCR 112 Site Cr plume and is not comingled. The VOC plume originating from the Schlumberger Site and the WCR 112 Site Cr plume are co-mingled south of I-20.

The WCR 112 Site was included on the National Priorities List (NPL) in 2011 based on evidence of potential exposure of residents to Cr through drinking water supplies. The Site is currently in the Remedial Investigation and Feasibility Study (RI/FS) stage of remediation. Site activities are conducted as a Fund-lead remedial project because no viable Potentially Responsible Parties (PRPs) were identified. A chronology of Site activities is listed in Table 3.

TABLE 3. West County Road 112 Ground Water Site Chronology

Date	Action
1994	Site inspection conducted by Texas Water Commission (TWC) at B&W Welding facility located near the presumed source of Cr. Contamination Cr found in soil.
2000	Property transaction assessment conducted at Former Lear Corporation Facility located adjacent to the B&W Welding facility.
2000-2008	Affected Property Assessment conducted at Former Lear Corporation Facility (Final APAR, 2008)
2009	Residents on West County Road 112 notified TCEQ of yellow-tinted water; TCEQ prepared Preliminary Site Inspection Work Plan
2009	TCEQ identified affected water supply wells and installed point of use (POU) water treatment units on those wells
2010	TCEQ conducted Expanded Site Investigation and attempted source identification, including investigation of the Williamson Gravel Pit
2011	Site listed on NPL
2012	EPA sampled groundwater in support of the RI
2014-2015	Schlumberger conducted pilot-scale in situ treatments for co-mingled VOC plume

3.2 REMEDIAL ACTION OBJECTIVES

The Record of Decision (ROD) is pending completion of the Site investigation; therefore, remedial action objectives (RAOs) for the Site have not been established. Short-term RAOs for the Site are anticipated to focus on prevention of human exposure to groundwater contaminated above EPA Maximum Contaminant Levels (MCLs) and control of groundwater plume migration. Long-term RAOs will include restoring the Ogallala aquifer and deeper Antlers Sand to beneficial use.

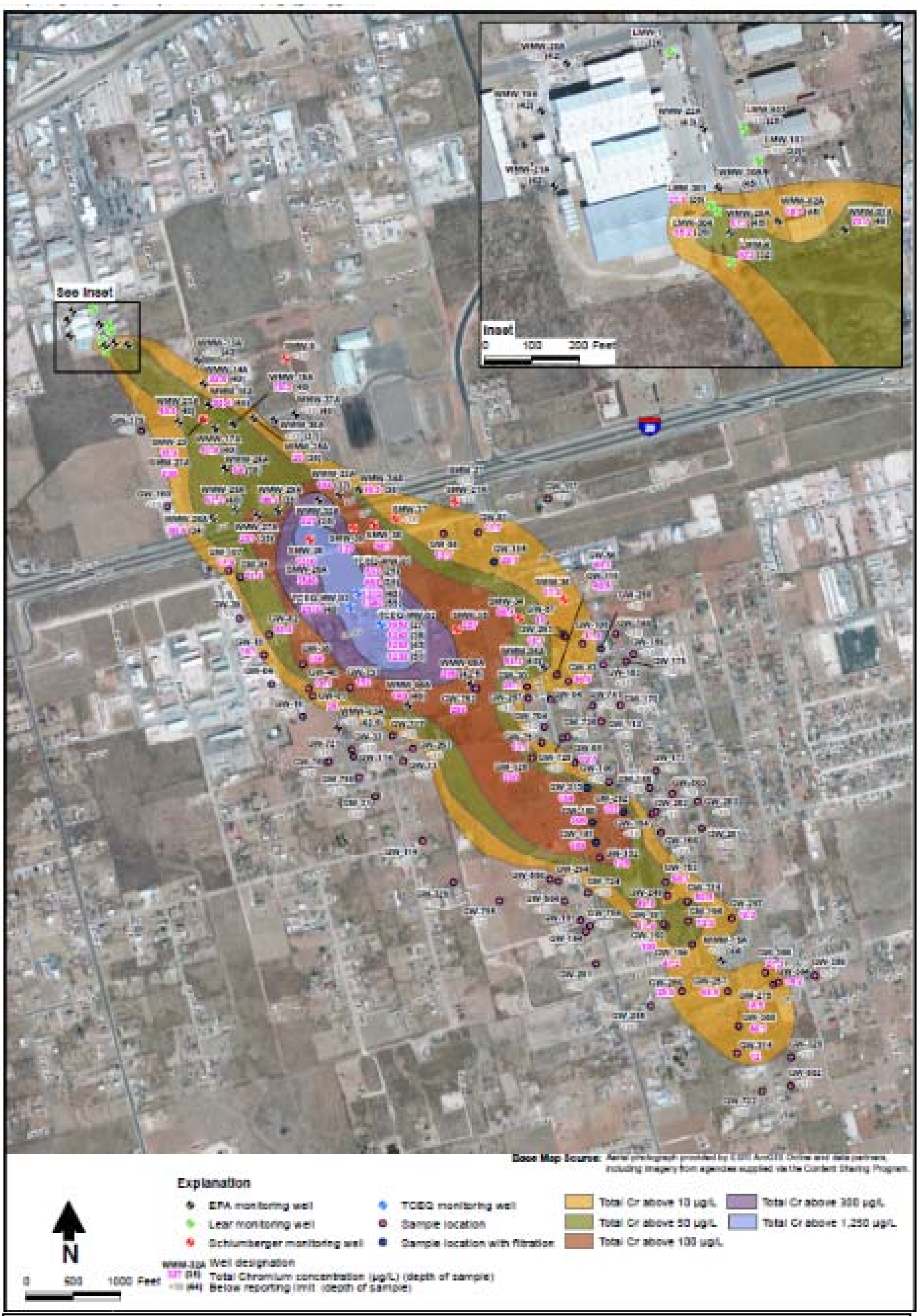

Figure 1: West County Road 112 Ground Water Superfund Site. Cr plume in the Ogallala Aquifer [Data from August 2014 EA (2014); full size images reproduced in Appendix B]

3.3 SELECTED REMEDY

Remedy selection for the Site is pending publication of the ROD or Interim ROD. Currently, TCEQ is operating POU treatment systems for properties with Cr-affected water supply wells. The POU treatments systems rely on anion exchange resins to remove Cr.

4.0 FINDINGS

4.1 WORKING CONCEPTUAL SITE MODEL

4.1.1 Geology and Hydrogeology

Site geology and hydrogeology vary from north to south across the Site. General Site stratigraphy derived from soil borings and monitoring well logs is summarized below.

- Surface soils consist of windblown sand and alluvium including sandy silts and silty sands extending from the surface to as deep as 15 feet (ft) below ground surface (bgs). However, most surface soils in the immediate vicinity of the Site are thin to absent.
- Caliche deposits (cemented calcium carbonate) underlie much of the Site and separate surface soils from the underlying saturated Ogallala Formation. Unsaturated deposits extend from near the surface to approximately 20 ft bgs and include silty sand, clayey sand, and gravel interspersed with caliche layers ranging from crumbly to very hard and impermeable to fractured in areas. Deposits between 0 to 25 ft bgs are highly heterogeneous. Cross sections developed for the suspected source area at the Former Lear Corporation property (Figure 2) indicate a combination of highly cemented zones interspersed with sandy layers, potentially creating preferential flow paths for migration of contaminants.
- The Tertiary Ogallala Formation consists of sandstone and fine to coarse-grained sand and fine gravel. Site sediments attributed to the Ogallala Formation are typically encountered between 10 ft to 60 ft bgs. The formation is saturated from 20 to 35 ft bgs and is unconfined. The Ogallala Formation appears to exhibit higher permeability north of I-20. Silty lenses south of I-20 may account for reduced permeability. The lower contact between the Ogallala Formation and the Trinity Group ranges from approximately 38 to 64 ft bgs. A clay layer, locally termed ‘false red beds’, consisting of red silty clay of 5 to 27 ft thick separates the base of the Ogallala from the Trinity.
- Trinity Group (Edwards-Trinity aquifer or Antlers Sand) is found below 50 to 65 ft bgs and extends to a depth of 67 to 95 ft bgs. The Antlers Sand consists of fine-grained sandstone containing scattered lenses of siltstone and coarse-grained sandstone with gravel in some locations. The Antlers Sand is saturated and unconsolidated, grading into cemented sandstone at depth. The Antlers Sand is confined by red clays both above and below the saturated interval.
- The Chinle Formation of the Dockum Group, known as ‘red beds’, consists of red clays and shales, and forms a confining aquitard below the Antlers Sands at approximately 80 to 100 ft bgs.

The Site is underlain by two water-bearing zones: The Ogallala aquifer (shallow zone) and the Antlers Sand (deep zone). Depth to water ranges between 20 ft bgs in the northern part of the Site to 35 to 40 ft bgs in the southern part of the Site. The saturated thickness of the Ogallala in the area of wells WMW-10, WMW-11, and WMW-12 above the false red beds is minimal (2 ft or less). Regional groundwater flow is from northwest to southeast in both aquifers. Well yield north of I-20 ranges from 3.3 to 25 gallons per minute (gpm), whereas yield south of I-20 drops off to 0.23 to 2.1 gpm (EA, 2013).

Borings advanced during the Schlumberger pilot test along I-20 (Schlumberger, 2014) indicate that an aquitard layer is present between the shallow saturated Ogallala Aquifer and the Antlers Sand. In the area of I-20, this layer is present between 45 to 72 ft bgs. The layer is predominantly composed of mudstone, with lenses of silty clay and sandstone. The saturated Trinity was found to be only 10 ft in thickness in this area (Schlumberger, 2014).

The connection between the Ogallala aquifer and the Antlers Sand is not well established south of I-20. Uncertainty regarding communication between the Ogallala aquifer and the Antlers Sand is a fundamental data gap in the CSM. The contact is defined in some locations by false red beds but this layer is not indicated on some boring logs, particularly in the southern part of the plume. Recharge and vertical plume migration to the Antlers Sand may occur through the Ogallala aquifer in areas where the false red beds are thin, where higher permeability strata meet, or through fractures in the clays.

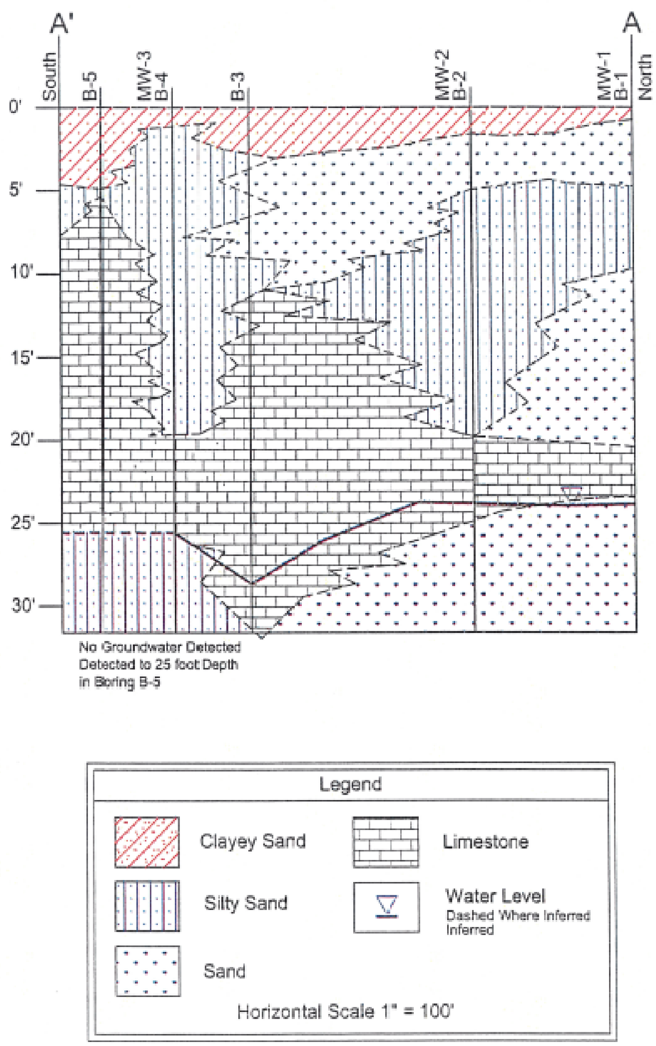

Figure 2: North to south cross section at Lear Corporation Facility [Excerpted from Lear APAR (2008); full size image reproduced in Appendix B]

Based on current data, the Cr plume migrates vertically to the Trinity in the area north of WMW-05. It is unclear if construction of WMW-05 caused cross-contamination between the Trinity and the Ogallala aquifers or if private water supply wells may provide communication between saturated units. Potentiometric surfaces between the Ogallala aquifer and Antlers Sand are similar, but there is some evidence of vertical head gradients, possibly due to significant withdrawal from the Antlers Sand by private water supply wells. Downward gradients may cause migration of contaminant plumes to deeper levels.

Aquifer parameters for the Ogallala include an estimated hydraulic conductivity (K) in the range of 0.007 centimeters per second (cm/s), a hydraulic gradient of 0.006, and an assumed effective porosity of 15 percent (AMEC, 2008). Groundwater seepage velocities in the Ogallala are estimated to be 280 ft per year (ft/yr) (EA, 2013). Cr exhibits limited retardation in groundwater, and groundwater extraction south of I-20 would accelerate Cr migration from north to south. For a plume length of approximately 11,500 ft, groundwater solute travel time from the source to the edge of the plume would be approximately 41 years.

Estimates of K from slug tests performed for the Schlumberger pilot test for the shallow Ogallala range from 6.20 to 16.9 ft/day (0.003 to 0.006 cm/s) whereas those for the deeper unit ranged from 0.04 to 0.42 ft/day (Schlumberger, 2014). Porosity in the Ogallala was estimated as low as 7.5 percent. These results indicate that there may be considerable differences in plume velocity across the aquifer systems.

The Cr plume appears to follow a preferential channel at the southern leading edge, possibly as a result of narrow seams of gravel in the southern part of the Site. Hydraulic gradients may trend from southeast to due south at the toe of the plume. Identification of preferential flow paths and confining layers is needed to support appropriate placement of remedies to intercept and control the plume and represents a data gap to be closed prior to remedy implementation.

4.1.2 Primary and Secondary Sources of Contamination

Site investigations did not conclusively identify a primary source of Cr discharge to groundwater. Potential primary sources investigated include the former B&W Welding facility, the former Lear Corporation Facility, the Williamson Gravel Pit, and the Schlumberger Technology Corporation (formerly Dowell Midland Facility) (EPA, 2010).

The former B&W Welding facility was previously investigated by the Texas Water Commission ([TWC] now the TCEQ) between 1984 and 1988 for potential Cr releases. The property was subject to foreclosure in 1985. Results of the TWC and subsequent investigations were inconclusive as to sources of Cr. Concentrations of Cr found at B&W were low, and no further action was pursued.

The Williamson Gravel Pit is a caliche borrow pit adjacent to the B&W facility. The pit provided material for construction of I-20 in the 1960s and was used, thereafter, to dispose of mixed construction waste. Illegal disposal of Cr waste may have occurred in the pit, but definitive evidence of a Cr source has not been found at this location.

TCEQ has subsequently identified the most likely source of Cr in groundwater as discharge of Cr-containing water from on-Site chillers or cooling towers at the former Lear Corporation Facility (EA, 2013). The Lear Corporation manufactured plastics at the 4 Industrial Loop South address. Historically, Cr has been used to prevent fouling in industrial chillers. TCEQ noted that water from chillers could have been discharged to an on-Site leach field at Lear dating back to the 1960s when the facility was developed. The chillers were reportedly removed in the 1980s (AMEC, 2008). Infiltration of Cr-containing wastewater between the 1960s and the 1980s was estimated to be sufficient to form a plume extending several miles downgradient. However, definitive evidence of releases and a precise mechanism of discharge were not identified. The Lear Corporation declared bankruptcy between 2008 and 2010. Cr concentrations remaining near potential sources are now low, with the majority of Cr mass downgradient of I-20 (Figure 1).

The Schlumberger Facility is located 1,000 ft north of the former Lear property. The VOC plume emanating from this location co-mingles with the Cr plume south of Schlumberger monitoring well SMW-9, continuing south of I-20 along Sunglo Road west of Cotton Flat Road (near well MW-26). Historical releases from the Schlumberger facility include VOCs, total petroleum hydrocarbons (TPH), and inorganic constituents including arsenic (As) (EPA, 2010). Contamination was discovered on the Schlumberger property in the mid-1980s, and remediation is currently being performed in cooperation with TCEQ under a 1994 Agreed Order (AO) under TCEQ's corrective action program (SWR # 33591).

4.1.3 Contaminants of Potential Concern

Contaminants of potential concern (COPC) at the Site include:

- Metals: Cr and arsenic
- VOCs: 1,1-dichloroethene (DCE), trichloroethene (TCE), tetrachloroethene (PCE), and VOC degradation products
- 1,4-Dioxane

Remedial goals for metals and VOCs are likely to be EPA primary MCLs. An MCL for 1,4-dioxane has not yet been established by EPA, but TCEQ has established a Protective Concentration Level (PCL) of 9.1 µg/L for 1,4-dioxane in tap water. Currently, the majority of contaminant mass is present in the

Ogallala Aquifer for all COPCs.

Arsenic is observed in the Ogallala aquifer at concentrations slightly above the MCL of 10 µg/L. The maximum plume concentration is 16 µg /L. Arsenic concentrations above 10 µg /L have been found in a limited area of the Antlers Sand downgradient from West County Road 114 since 2014. The source of arsenic in groundwater is uncertain, but appears to be a result of reducing conditions generated by releases from the Schlumberger facility. Pilot testing of in situ reductant along I-20 has demonstrated that arsenic and other metals can be mobilized under anaerobic conditions. Thermodynamic data for arsenic indicate that mobile forms of arsenic can be converted to less mobile arsenate species under aerobic aquifer conditions; however, it is uncertain how far arsenic can travel at the Site before natural attenuation processes decrease concentrations below the MCL or eventual cleanup goal.

In June 2012, Schlumberger and EPA collected groundwater split samples for independent analysis. During this sampling, 1,4-dioxane was detected in several EPA samples at concentrations exceeding TCEQ PCLs. Historically, 1,4-dioxane was used as a stabilizer in industrial solvent products containing 1,1,1,-trichloroethane (1,1,1-TCA). While no 1,1,1-TCA remains in the plume, 1,1-DCE, the spontaneous degradation product of 1,1,1-TCA, is present at concentrations exceeding MCLs. The compounds 1,1-DCE and 1,4-dioxane are more mobile than TCE, the primary contaminant in the Schlumberger plume, and may indicate further plume expansion into the Cr-affected zone.

Cr is the COPC with the greatest toxicity and mobility at the Site based on the Hazard Ranking System (HRS) score (EPA, 2010). The current EPA Primary Drinking Water Standard MCL and remedial goal for total Cr is 100 µg/L. Recently, the safety of the 100 µg/L standard has been reviewed based on the differential toxicity of Cr oxidation states and reassessment of the toxicity of Cr via oral ingestion pathways (ATSDR, 2012 and EPA, 2015).

Cr exists in two principal oxidation states under standard conditions in the environment. Trivalent Cr or Cr (III) is the reduced and most stable form of the element, whereas hexavalent Cr or Cr (VI) is the oxidized and more reactive form. The two oxidation states display different geochemical, fate and transport properties as well as toxicological effects. Cr (III) is poorly soluble with limited mobility, and is poorly reactive, resulting in limited toxicity. Reaction thermodynamics do not favor re-oxidation of Cr (III) under most environmental conditions.

Conversely, Cr (VI) is highly soluble, reactive, and mobile in the environment. Cr (VI) can be rapidly reduced under environmental conditions in highly anaerobic sediments. However, natural attenuation processes for Cr (VI) in aerobic aquifers are extremely slow.

Cr (VI) is classified as a possible human carcinogen, and is responsible for the majority of hazard and excess risk to human and ecological receptors from Cr species (ATSDR, 2012). Cr (VI) is known to be hazardous by inhalation, but toxicity by oral ingestion was assumed to be limited as stomach acids were thought to convert Cr (VI) to Cr (III) in the stomach. Recent toxicology data indicate exposure via the oral route may result in increased risk of carcinogenic lesions (ATSDR, 2012).

Several regulatory programs have proposed human health-based updates to the federal MCL. The state of California has maintained a state MCL of 50 µg/L since 1977 and has established a public health goal (PHG) of 0.02 µg/L since 2011 (OEHHA, 2011). The California Department of Public Health proposed a new state MCL of 10 µg/L in August 2013. The state of New Jersey has considered an MCL for Cr (VI) of 0.7 µg/L. EPA is currently reviewing existing data on Cr (VI) toxicity (EPA, 2015). The June 2015 EPA Regional Screening Level for Cr (VI) in drinking water is 0.035 µg/L. Given the trend of toxicological information about Cr (VI) and ongoing regulatory review of protective concentrations, a reduction in the federal MCL will likely occur in the future.

4.1.4 Affected Media, Exposure Pathways and Potential Receptors

Groundwater ingestion is the primary potentially complete exposure pathway at the Site. The City of Midland provides municipal water to the area north of I-20. South of I-20, in Midland County, the sole water supply is the Ogallala/Edwards-Trinity Aquifer system, and residents are served by private water supply wells. There are currently several hundred private water supply wells in the area of the groundwater plumes.

According to Site documents, most private supply wells are drilled to 100 ft bgs and screened across both aquifers to maximize production as yields are low (EPA, 2010). Extension of City of Midland municipal water supplies to the area residents is unlikely in the short-term. Midland may be more willing to extend municipal lines after additional regional water rights and supplies are developed in adjacent counties.

Currently, TCEQ operates POU anion exchange units at private drinking water wells exceeding Cr MCLs. Responsible parties for the Schlumberger plume operate POU filtration units specific for chlorinated VOCs at affected private water supply wells. TCEQ conducts performance sampling of the POU units for Cr removal. It is unknown if the Schlumberger PRP group conducts sampling and analysis for arsenic or 1,4-dioxane for their POU systems. The potential comingling of the Schlumberger and Cr plumes may complicate efforts to organize, operate and manage appropriate POU treatment systems.

EPA and TCEQ have encountered problems accessing some private water supply wells for sampling and maintenance of existing POU systems, and for installation of new systems. Property access issues may complicate both the evaluation of potential risk and the placement of monitoring wells and remedies in the area.

Given the likely age of Cr releases (1960s through early 1970s) and low residual dissolved concentrations of Cr north of I-20, significant soil or vadose zone contamination is unlikely. The only remaining medium of concern at the Site appears to be groundwater.

4.2 GROUNDWATER MONITORING

The available dataset for the Site includes groundwater data from numerous well locations and types as well as various monitoring programs. Sampling locations are illustrated on Figure 1 and Figure 3 and include:

- Private water supply wells (“GW” well designation)
- Lear monitoring wells (“LMW” well designation)
- Schlumberger monitoring wells (“SMW” well designation)
- TCEQ monitoring wells (“TCEQ-MW” well designation)
- EPA wells (“WMW” well designation).

The Site south of I-20 contains over 200 private water supply wells. Sampling results from these locations have provided the majority of data to identify the extent and magnitude of the plume. Private water supply wells are typically drilled to the base of the Antlers Sand at 100 ft bgs and are screened across both aquifers. The construction details and elevations of private wells are not always known. Although data from private wells provides good spatial data density, the lack of specificity regarding the source of water to wells (from the Ogallala aquifer or the Antlers Sand) introduces uncertainty into the interpretation of data from these locations.

The suspected source area is monitored by a few Lear property wells and wells drilled by EPA. Lear wells are sampled to confirm low concentrations remaining in the suspected source and to identify the extent of arsenic-affected groundwater. Schlumberger monitoring wells are located north and east of the main plume north of I-20, but provide relevant data for Cr and arsenic immediately south of I-20. Three TCEQ wells are placed in what appears to be the center of the Cr plume mass along West County Road 112.

Boring logs for Schlumberger and TCEQ wells were not reviewed for this report.

EPA has installed approximately 60 monitoring wells across the Site, screened in the Ogallala Aquifer and Antlers Sand. Several EPA wells are located north of I-20 and monitor the northern edge of the plume with concentrations below remedial goals. The network of EPA wells is sparse south of I-20, with transects near West County Road 114 and West County Road 117. The western and southern extent of the Cr plume is defined only by data from private water supply wells.

Potentiometric surface maps drawn using data from the EPA and TCEQ monitoring wells provide sparse data for estimating potential migration pathways. Data gaps in groundwater elevations exist in the area south of WMW-08 to WMW-11 where groundwater flow may be influenced by area pumping or preferential flow channels. Boring logs for WMW-11 depict a gravel layer between 53 and 73 ft bgs that is not seen at adjacent wells WMW-12 and WMW-10 and may serve as a preferential flow channel.

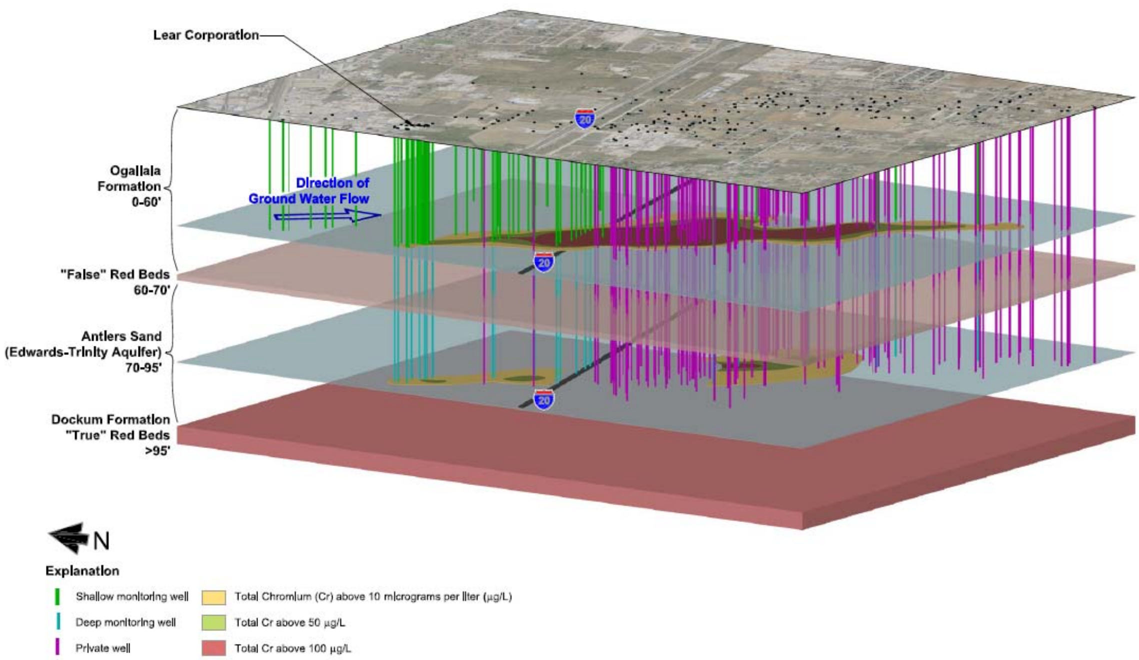

Figure 3: Conceptual Block Diagram illustrating sampling locations in shallow and deep zones. [Excerpted from EA (2013) *Conceptual Understanding of the Site Technical Memorandum*; full size image reproduced in Appendix B]

4.3 GROUNDWATER REMEDY CONSIDERATIONS

The Site is in the RI/FS stage of remediation, and a remedy has not yet been selected for the Site. TCEQ is currently operating POU anion exchange systems for area residents to address the groundwater ingestion exposure pathway for Cr. The cost and level of effort to maintain the anion exchange resins in the POU systems is high. The change-out schedule for resin is on the order of every two to six weeks depending on water use and concentration of Cr (EA, 2013). Some well owners use treated water for landscaping and other outdoor purposes, shortening the life-span of resin in the filters.

Remedial approaches currently considered for plume control, detoxification, and aquifer restoration include groundwater extraction, treatment and reinjection (pump and treat [P&T]), and/or in situ reduction of Cr (VI) to Cr (III).

A pilot test for in situ treatment of VOCs was conducted by Schlumberger in 2014. Pilot test plots were established just south of I-20 on the Abell Hanger Foundation Property. Treatment techniques tested include cometabolic aerobic biodegradation, enhanced reductive dechlorination (ERD), and in situ chemical oxidation (ISCO) using catalyzed hydrogen peroxide. The ERD approach for targeting VOCs is nearly identical to in situ reduction technology to treat Cr (VI). Consequently, results of the ERD pilot test may provide useful information for designing in situ treatment for Cr.

The ERD test for VOCs used emulsified vegetable oil (EVO) to create anaerobic conditions in the subsurface, favoring microorganisms capable of degrading VOCs through reductive dechlorination. Data collected during the pilot test indicate that EVO injections reduced dissolved oxygen (DO) and oxidation/reduction potential (ORP) and increased concentrations of total organic carbon (TOC), manganese (Mn), iron (Fe), and methane in the subsurface. Some increases in arsenic concentrations were observed. Overall test result showed that EVO created reducing conditions sufficient to stimulate degradation of VOCs. These conditions are also likely to support reduction of Cr (VI) to Cr (III).

4.4 SUMMARY OF FINDINGS

Findings are based on a review of Site documents, Site visit, and discussions with EPA and TCEQ.

- Groundwater plume migration is not controlled. Plumes are expanding southward.
- Multiple private water supply wells south of I-20 draw water from contaminated aquifer zones. Cr concentrations are above the EPA MCL of 100 µg/L. Many other wells have concentrations between 10 µg/L and 100 µg/L, in a range that may be regulated at some time in the future. Area private water supplies are also affected by elevated concentrations of arsenic and VOCs from an unrelated groundwater plume.
- Anion exchange POU treatment units on private water supply wells are expensive to maintain and may not be removing potential co-contaminants from the plume emanating from the Schlumberger property such as arsenic and 1,4-dioxane.
- Hydrogeology at the Site is complex. Potential connections between the upper Ogallala Aquifer and the deeper Antlers Sand are not well established. Preferential channels may exist in both aquifers, influencing migration of contaminants. Data gaps include a lack of understanding of the communication between the shallow Ogallala Aquifer, the deeper Antlers Sand, and the intervening confining clays and gravel layers. The majority of the sampling locations south of I-20 are private water supply wells with long screened intervals. The number of monitoring wells that target specific depth intervals and include geological information from boring logs is sparse.
- Cr has migrated vertically to the lower Trinity Formation in the area of WMW-05 near West County Road 114.
- The source of Cr releases to groundwater is unknown. Based on the distribution of mass in the plume, continued input of Cr from the source is limited. Further investigation or remediation at the historical source is likely unproductive.
- The majority of dissolved Cr mass has migrated south of I-20. No estimates of the total mass of Cr in the plumes have been developed. Estimates of the potential efficacy and cost of future remediation may be hard to predict.
- The distribution of Cr south of I-20 is largely based on data from private water supply wells where the sampling interval and elevation of the wells are not well documented. Supply wells are

screened across both aquifers, but data are reported and mapped as Ogallala results, introducing uncertainty into estimates of the distribution of contamination.

- The Cr plume and a VOC plume originating from the Schlumberger Technology Corporation facility are comingled south of I-20.
- In situ reduction of Cr (VI) to Cr (III) may be an effective remedy at the Site; however, the in situ treatments will most likely generate secondary metals such as Mn, Fe, and arsenic as well as odors that may affect water quality.

5.0 RECOMMENDATIONS

Recommendations are provided that impact the five major areas associated with optimization: remedy effectiveness, cost reduction, technical improvement, site closure, and environmental footprint reduction. Table 4 provides a summary of the recommendations and estimated costs (or savings) for implementing each recommendation.

The levels of certainty for the cost estimates provided are comparable to those typically prepared for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) FS reports (-30 to +50 percent) and are considered approximate estimates for planning purposes.

5.1 RECOMMENDATIONS PERTAINING TO ALTERNATE WATER SUPPLIES

RAOs addressing human ingestion of contaminated groundwater should be prioritized for inclusion in a decision document in the near future. Due to the size and complexity of the large Cr plume, aquifer restoration will require many years of remediation and, most likely, additional Site characterization data derived from initial remedy performance. An Interim ROD addressing plume control and elimination of exposure routes in the short-term could be considered.

Currently, maintenance of POU treatments units is both cost and labor intensive. As the Cr plume migrates, additional private supply wells may become affected. A reduction in health-based standards for Cr or addition of an MCL or PCL specifically for Cr (VI) may trigger the need for alternate water supplies at many more private supply wells to ensure conditions protective of human health.

Options for alternate drinking water supplies include extension of municipal supply lines, modification of POU treatments units, and delivery of bottled water. Extension of City of Midland municipal supply lines is the preferred long-term solution to prevent exposure through drinking water. However, extension of municipal supplies requires cooperation with the City of Midland, and extension of service to the county residents may be delayed until Midland constructs infrastructure sufficient to serve residents or secures water supplies to support extending service.

POU treatment systems can effectively remove Cr, but are not designed to remove potential co-contaminants such as Mn, Fe, arsenic, and VOCs derived from other sources. The cost of POU treatment is related to the volume of water treated. POU treatment systems could be modified to supply only drinking water, diverting water used for landscaping, agriculture, or other outdoor use before treatment. For most locations, Cr levels are not hazardous for non-potable water use. Reducing the amount of water flowing through treatment systems is one way to lengthen the change out time of resin.

Delivery of bottled drinking water may be a cost-effective option for many private well owners. Groundwater data indicate that the Ogallala Aquifer and Antlers Sand exceed Federal secondary standards for chloride, sulfate, and total dissolved solids (TDS) in many areas. Due to exceedance of aesthetic standards, delivery of bottled water may be a preferred option for many residents.

Recommendations to ensure conditions protective of human health include the following:

- Long-term planning for extension of municipal water supplies to the area south of I-20;
- Community outreach to inform residents of potential health risks from groundwater consumption;
- Review of POU treatment systems to determine if water for non-potable use can be diverted before treatment to extend the life of anion exchange resins;

- Provision of bottled water, particularly for residents downgradient from in situ treatment remedies or where the VOC and Cr plumes intermingle;

The optimization team recommends identifying properties within 1,000 ft downgradient or 200 ft cross-gradient of the Cr plume, using 100 µg/L as the plume boundary and planning for provision of alternate water supplies to these properties. This is a protective measure against potential exposure through continued migration of Cr plume in the short term and will further reduce risk relative to the 100 µg/L MCL. The optimization team has not provided a cost estimate for this recommendation due to the uncertainty in the savings that will be realized by diverting water for non-potable uses.

5.2 RECOMMENDATIONS PERTAINING TO CSM DATA GAPS

Primary data gaps associated with the WCR 112 Site include the geology and hydrogeology, particularly for the area south of I-20. Geophysical and boring logs as well as plume distribution indicate there are preferential vertical and transverse plume migration pathways.

5.2.1 Groundwater Monitoring

The majority of data used to define the magnitude and extent of the groundwater plume south of I-20 is from private water supply wells screened across both Ogallala Aquifer and Antlers Sand. Data from private wells represent potential mixing of water from both units, creating uncertainty about the location of contaminant mass. In addition, private supply wells do not provide accurate groundwater elevations because they are not surveyed and construction details are not well documented.

The optimization team recommends installation of additional monitoring wells to both define the magnitude and extent of contamination in the Ogallala aquifer and Antlers Sand and provide better hydrogeologic characterization data on potential preferential flow paths.

Additional monitoring wells are recommended for the following areas:

- *Ogallala Aquifer and Antlers Sand along a line from GW-150 west to GW-114, south of GW-126.* The lateral extent of contamination west of GW-150 is not delineated. Two nested monitoring wells are recommended along the trajectory of West County Road 116 west of GW-150 in order to evaluate current conditions and confirm groundwater flow direction. The wells will monitor remedy performance and efficacy if an in situ reduction treatment zone is installed along West County Road 115 (see Section 5.3.1).
- *Upgradient Antlers Sand well.* Cr is migrating vertically to the Antlers Sand either north of WMW-05A/B or in the area of WMW-05A/B. An additional monitoring well in the Antlers Sand is recommended upgradient of WMW-05A/B (west of SWM-35) to evaluate Antlers Sand Cr concentrations upgradient of WMW-05A/B. The well should be double cased to prevent incidental cross contamination associated with installation of the well. If WMW-05B is determined to be the source of Cr in the lower aquifer, the well should be plugged and abandoned. If Cr is migrating into the Antlers Sand upgradient of WMW-05A/B, then the location of likely vertical migration will need to be located so that future remedial efforts can address the Ogallala Aquifer contamination before it migrates into the Antlers Sand.
- *The leading edge of the plume south of WMW-15 is not defined.* An additional monitoring well pair south and east of WMW-15, south of GW-257 is recommended to confirm Cr concentrations detected in private supply wells and to serve as a sentinel for future plume migration.

Collection of subsurface samples from the caliche or highly indurated strata is technically difficult. The Site team reports that Rotosonic drilling is not effective and that air rotary is the preferred drilling method. Air rotary drilling limits the ability to collect solid samples and better understand the subsurface geology. If possible, the Site team might consider using air rotary to penetrate the caliche and then use Rotosonic drilling beneath the caliche to obtain better information about the stratigraphy and distribution of contamination in the vadose.

While the source area has not been identified, low concentrations in the most upgradient portions of the plume indicate that continued flux from non-remediated sources is not introducing significant mass to the plume. No new monitoring wells are recommended north of I-20. Existing monitoring wells north of I-20 can be sampled infrequently (biennially) as concentrations do not exceed remedial goals.

Existing monitoring wells south of I-20 should be sampled semi-annually for four years during and after remedy installation to attain a statistically significant sample size. A synoptic sampling of all monitoring and private supply wells should be conducted prior to the first Five-Year Review. Monitoring locations, including private supply wells, should be monitored for Mn, Fe, and arsenic to evaluate these analytes before and after ERD treatment planned by Schlumberger and the potential in situ treatment discussed in Section 5.3.1.

The optimization team estimates that installing the five recommended monitoring wells might cost $75,000, including planning and documentation. No cost estimate is provided for the recommended sampling because the optimization team expects that the recommended sampling is generally similar in level of effort to what would have been implemented in the absence of the recommendation.

5.2.2 Site Geology and Data Interpretation

The optimization team recommends development of detailed cross sections using data from current and recommended monitoring and in situ injection well installations (see Section 5.3.1). All existing boring geophysical logs should be reviewed. If possible, borings and/or data from the Schlumberger monitoring wells should be included.

Cross sections should be used to update the CSM with a focus on the presence/absence/thickness of the false red beds. Site stratigraphy should be reviewed with respect to potential vertical migration of contamination from the Ogallala aquifer to the Antlers Sand, the saturated thickness of the Ogallala Aquifer versus the Antlers Sand at various locations, and preferential downgradient flow channels in both aquifers.

Elevation data from new wells should be used to update groundwater potentiometric maps, with particular attention to the direction of groundwater flow near WMW-10, WMW-11, and WMW-15.

The optimization team estimates that organization of the data and development of the recommended cross sections would cost less than $10,000.

5.3 RECOMMENDATIONS FOR GROUNDWATER REMEDY COMPONENTS

5.3.1 In Situ Reduction Interim Remedy

The optimization team recommends that the Site team consider an in situ reduction treatment remedy alternative as part of an interim remedy for the Site to prevent further migration of the high concentration portion of the Cr plume. The location of the treatment zone would be based on property access. Based on observations during the Site walk and discussions with the Site team, the mostly likely location of the treatment zone would be across the plume core in the vicinity of and parallel to West County Road 115. This location is private property used for agricultural purposes. If access cannot be gained for this location, then injection wells could be installed along County Road 114.

Plume maps based on available data suggest that the Cr plume above 100 µg/L is relatively narrow (500 ft across) in this location, but this depiction could be the result of a lack of data. The optimization team recommends installing 2-inch polyvinyl chloride (PVC) injection wells at 60-ft spacing between each injection well. The injection wells should have 10-ft screen intervals in the Ogallala aquifer, and multiple injection wells may be needed in each location to characterize and treat the entire contaminated interval. The injection wells should be sampled for Cr to refine the treatment volume and understanding of the stratigraphy in the vicinity of the treatment zone. Based on the sampling results and boring logs, additional injection wells can be installed to achieve 15-ft spacing between wells in areas that are targeted for treatment. The vertical injection intervals can be adapted based on the boring logs. Vertical injection intervals greater than 20 ft are not recommended, and multiple vertical injection intervals per injection location may be required.

For an initial round of injections, the Site team can adopt results from the injections conducted at the Sprague Road Groundwater Plume Site (Sprague Road). At Sprague Road, the likely injection spacing will be 15-ft with a 20-ft injection interval, 500 gallons of amendment, and 14,500 gallons of water (including 1,000 gallons of chase water). Unless more specific information is available from the Schlumberger pilot study, similar values can be used for the Site.

Two sets of performance monitoring wells should be installed to monitor remedy performance. Each set of performance monitoring wells should include wells 25 ft, 50 ft, and 100 ft downgradient of the injection wells as access allows, and multiple monitoring wells may be needed in each location to screen relevant depth intervals. One set should be installed in line with an injection location, and the other set should be installed in line with the gap between injection locations. Monitoring should be conducted quarterly at these wells for two years to evaluate amendment performance, amendment dose, and the generation of Mn, Fe, and arsenic. Based on the performance monitoring results and the distance to downgradient water supply wells, the Site team can determine the need to include biosparging wells more than 200 ft downgradient of the injection wells to oxygenate the water and accelerate attenuation of these secondary metals.

The alternative should consider the potential for a treatment zone in the Antlers Sand, but implementation of this deeper treatment zone should be contingent on the findings from the new Antlers Sand monitoring well near SMW-35 (see Section 5.2.1).

The data used from this interim remedy can be used to inform the final remedy for the Site, which might include treatment zones in other locations once private properties are connected to public water supplies. Information pertaining to well spacing, amendment type, amendment dose, injection frequency, treatment efficacy, generation and attenuation of secondary metals, and access from this interim remedy should be incorporated into the final remedy.

For preliminary cost estimates, the optimization team assumes that 100 injection wells will be needed plus the 12 performance monitoring wells. The first injection using approximately 50,000 gallons of amendment and over 1.4 million gallons of water is anticipated to last approximately two years. The monitoring frequency of the performance monitoring wells for subsequent injections can be modified accordingly, perhaps using semiannual sampling. Existing wells WMW-10, WMW-11, and WMW-12, which are approximately 1,500 ft downgradient suggested in situ treatment zone can be used to monitor long-term effectiveness.

Analytes for performance monitoring for the first two years will include total Cr, Mn, Fe, arsenic, pH, alkalinity, DO, TOC, ORP, sulfate, and nitrate. The parameter list can be modified after the first two years of sampling. Analysis should include speciation of Cr (III) and Cr (VI) annually from the performance monitoring wells for the first two years.

The optimization team estimates that this interim remedial approach may cost $1.2 million for planning, well installation, sampling, an initial injection event, performance monitoring, and annual reporting. Additional cost would be needed if biosparging were conducted to oxygenate the aquifer downgradient of the treatment zone to address increased Mn, Fe, and arsenic generated from the in situ treatment.

5.3.2 Other Remedial Options

If the in situ treatment is not successful or is impractical for various reasons, the leading alternative approach would be a P&T system. The treatment technology for the P&T system would depend on the findings from the Sprague Road evaluations. If the existing photo-catalysis treatment system (Photo-Cat system) operation can be improved, then the Photo-Cat system would be an appropriate treatment technology. If the Photo-Cat system operation cannot be reliably improved, then ion exchange would be the likely treatment technology for extracted groundwater.

5.4 SUGGESTED SEQUENCING FOR IMPLEMENTING RECOMMENDATIONS

- Investigate alternative sources of drinking water for residences with private supply wells in accordance with Section 5.1. Supply bottled drinking water for residences that may be affected by primary or secondary contaminants. POU treatment systems should be modified to divert water used for non-potable, outdoor uses such as landscaping and livestock water.
- Install suggested monitoring wells and conduct recommended Site-wide groundwater monitoring in accordance with Section 5.2.1.
- Develop a detailed cross section in accordance with Section 5.2.2.
- Exchange information on stratigraphy (borings in vicinity of pilot study) and potential mobilization of secondary metals from in situ reduction treatments with Schlumberger responsible parties.
- Continue interactions with the City of Midland to plan for the extension of municipal water supply lines south of I-20.
- Prepare an Interim ROD selecting provision of alternate water supplies and in situ reduction treatment as interim remedies.
- Install the in situ treatment zone in accordance with Section 5.3.1 and conduct associated performance monitoring.

TABLE 4. Recommendations and Cost Summary

RECOMMENDATION	REMEDY EFFECTIVENESS	COST REDUCTION	TECHNICAL IMPROVEMENT	SITE CLOSURE	ENVIRONMENTAL FOOTPRINT REDUCTION	ESTIMATED LIFE-CYCLE COST	CHANGE IN ANNUAL COST
5.1 Provide/Modify Alternate Water Supply	X	X	X	NA	NA	Not estimated	NA
5.2.1 Groundwater Monitoring	X	NA	X	X	NA	$75,000	NA
5.2.2 Data Analysis and Cross Sections	X	X	X	X	NA	$10,000	NA
5.3.1 In Situ Reduction Interim Remedy	X	X	X	X	NA	$1.2 million	NA
5.3.2 Other Remedial Options	X	NA	NA	X	NA	Not estimated	NA

"X" Indicates that the recommendation pertains to the indicated optimization category
"NA" Indicates the recommendation is not appropriate to the indicated optimization category

APPENDIX A:
REFERENCES

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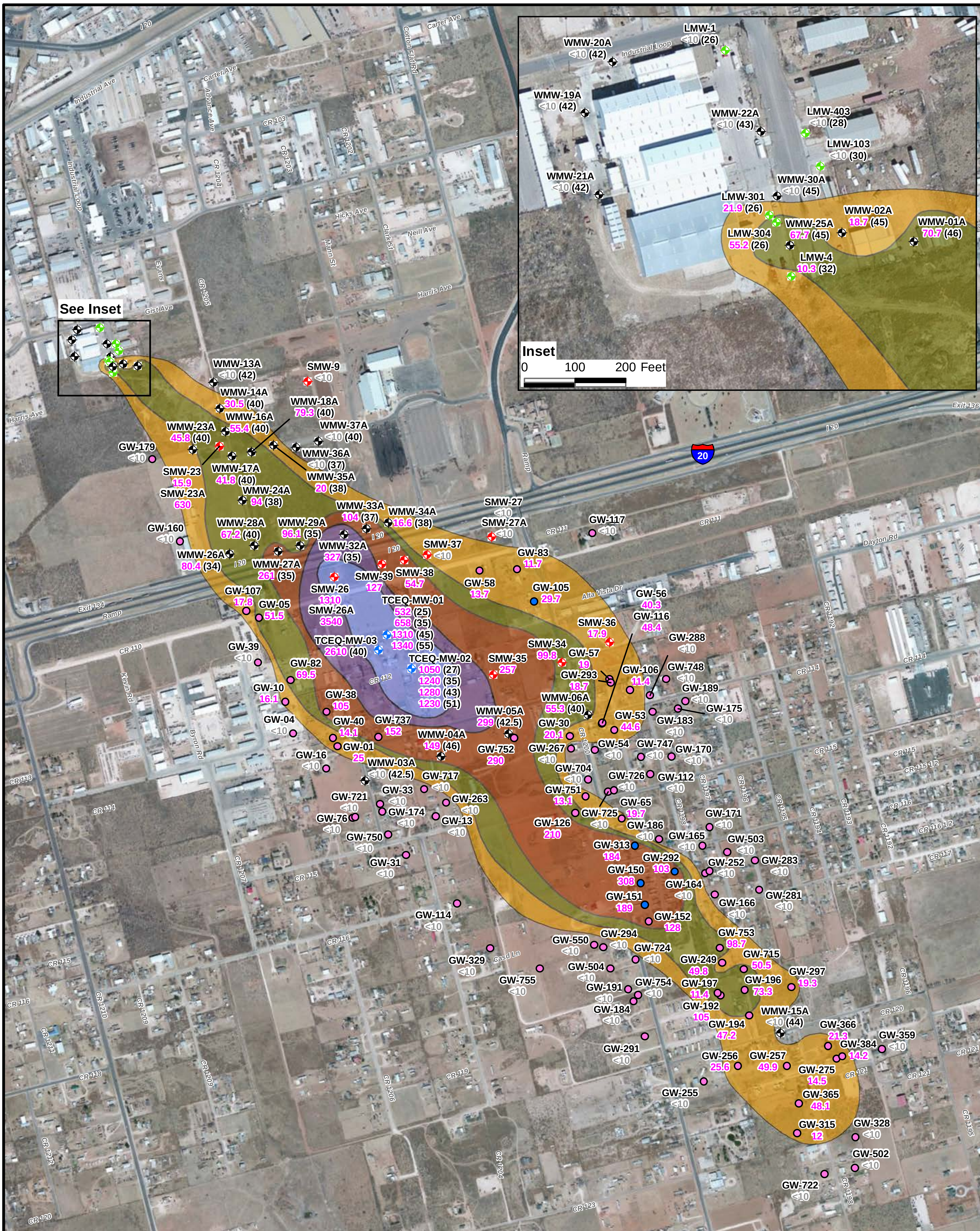
APPENDIX B:
SUPPORTING FIGURES

M:\Projects\EPA_RAC\EPA6.14_West County Rd 112\GIS\MXDs\Chemistry\CR_map_shallow_8_2014.mxd



Explanation

EPA monitoring well	TCEQ monitoring well	Total Cr above 10 µg/L
Lear monitoring well	Sample location	Total Cr above 50 µg/L
Schlumberger monitoring well	Sample location with filtration	Total Cr above 100 µg/L
		Total Cr above 300 µg/L
		Total Cr above 1,250 µg/L

N

0 500 1000 Feet

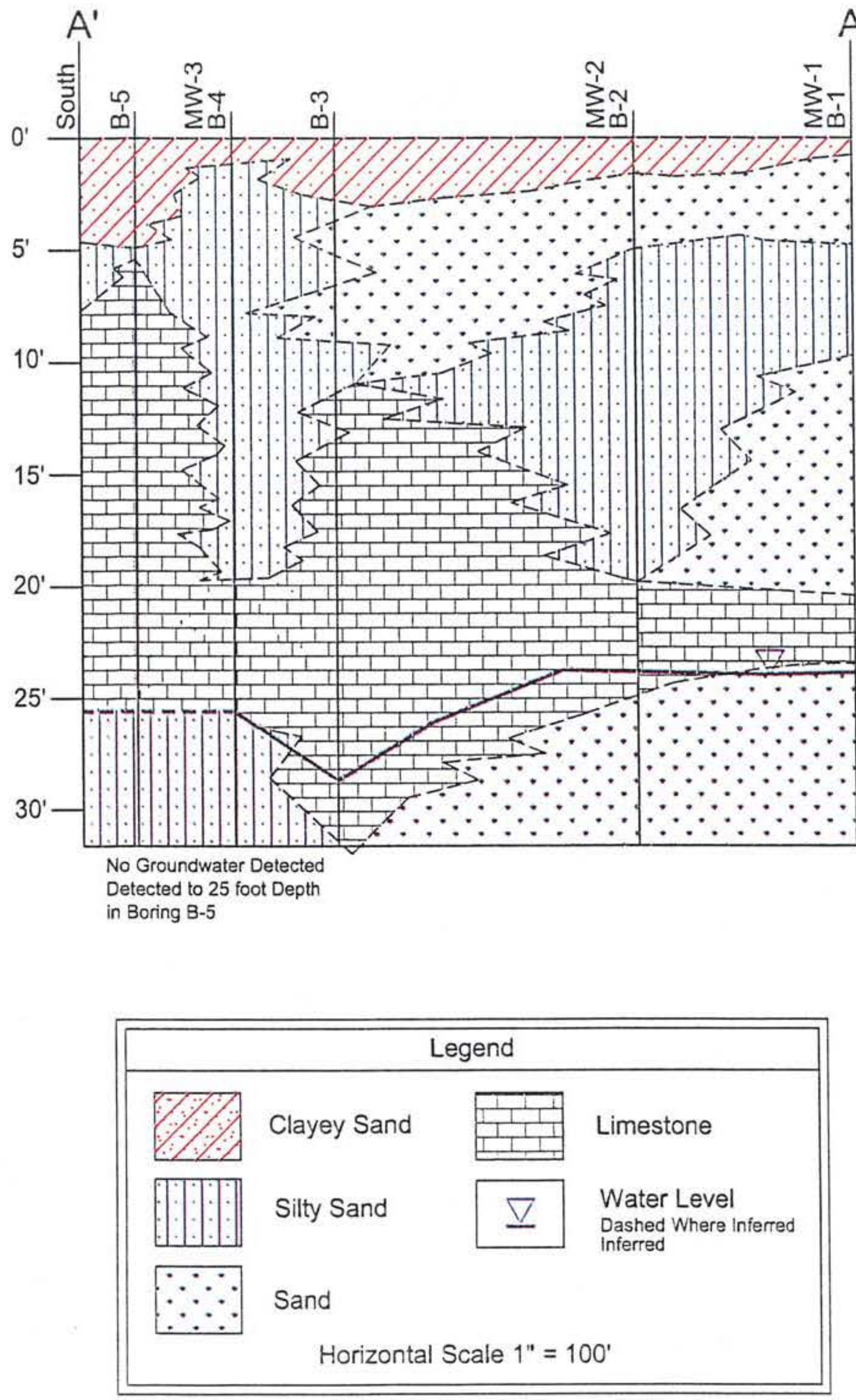
WMW-32A Well designation
327 (35) Total Chromium concentration (µg/L) (depth of sample)
<10 (44) Below reporting limit (depth of sample)

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

WEST COUNTY ROAD 112
GROUND WATER PLUME SITE
MIDLAND COUNTY, TEXAS

Concentrations of Total Chromium in the Ogallala Aquifer August 2014

DESIGNED BY	DRAWN BY	CHECKED BY	SCALE	DATE	PROJECT NO	FIGURE
DWR	CRS	DWR	1:12,000	11/13/2014	1434265	.



STATE OF TEXAS
BRENDA BARNES
GEOLOGY
3699
LICENSED
PROFESSIONAL GEOSCIENTIST

BBarnes
10/3/08

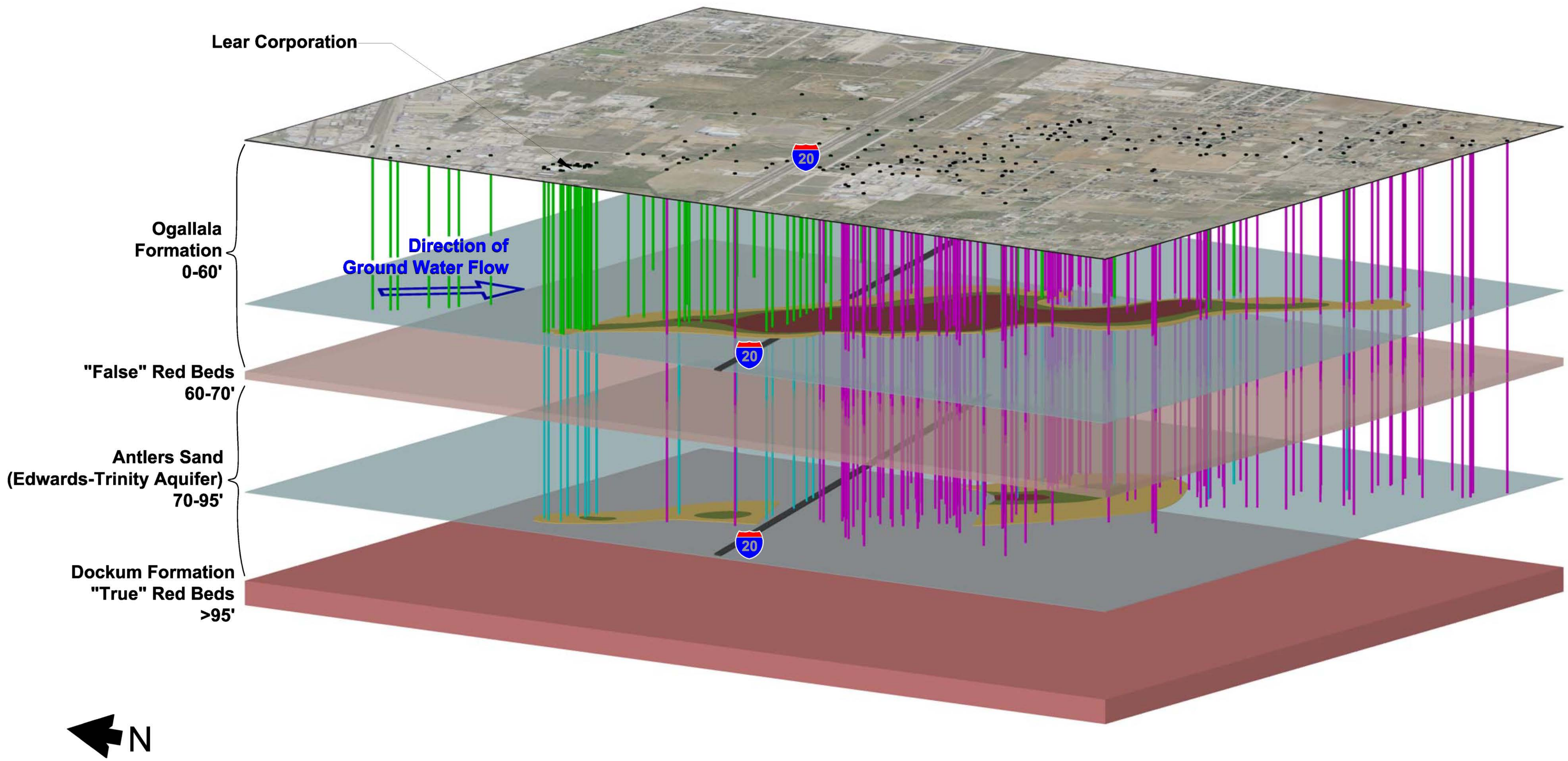
ditional Assessment Activities
Former Lear Corporation Site
4 South Industrial Loop
Midland, Texas
AMEC Job No. 3-762-60000

Attachment 2F2

Cross Section A-A'
North to South

amec EARTH AND ENVIRONMENTAL, INC.
ONE PLYMOUTH MEETING, SUITE 350
PLYMOUTH MEETING, PA 19462-1308

Dwn by: C. Holguin
Check'd by: B. Barnes
File No.: P:\Drafting2\2003\3-762-60000\CrossSect AA.dwg



Explanation

Shallow monitoring well	Total Chromium (Cr) above 10 micrograms per liter (µg/L)
Deep monitoring well	Total Cr above 50 µg/L
Private well	Total Cr above 100 µg/L

Conceptual Block Diagram

WEST COUNTY ROAD 112
GROUND WATER PLUME SITE
MIDLAND COUNTY, TEXAS

EA ENGINEERING, SCIENCE, AND TECHNOLOGY

FIGURE	11
PROJECT NO	1434265 B 1
DATE	10/24/2012
SCALE	1:9600
CHECKED BY	DWR
DRAWN BY	CRS
DESIGNED BY	DWR